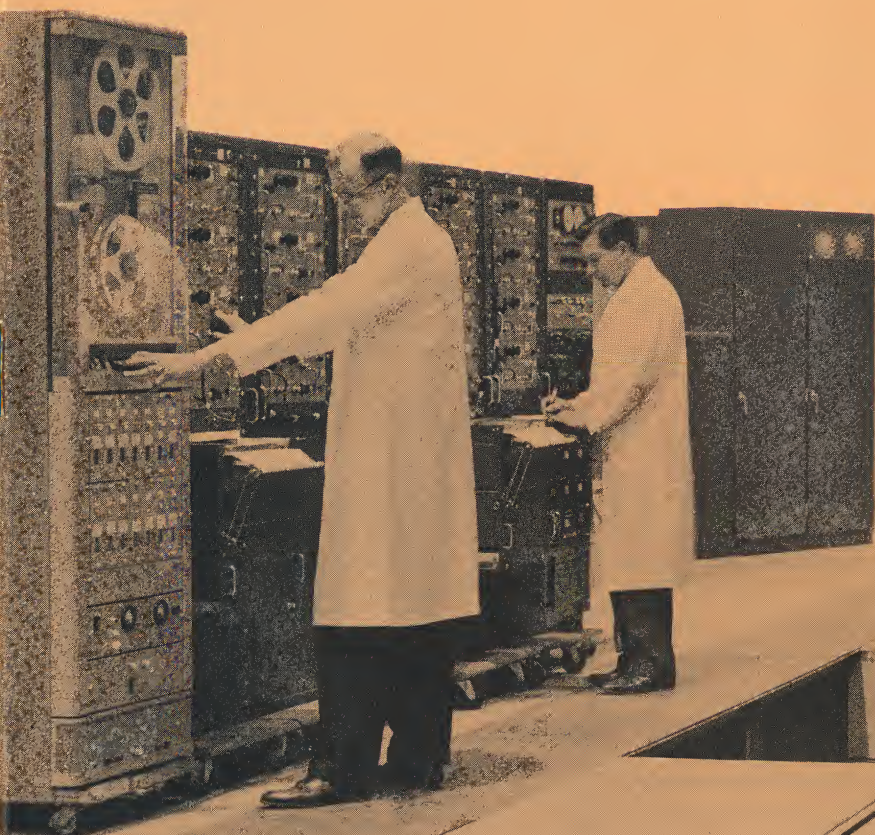
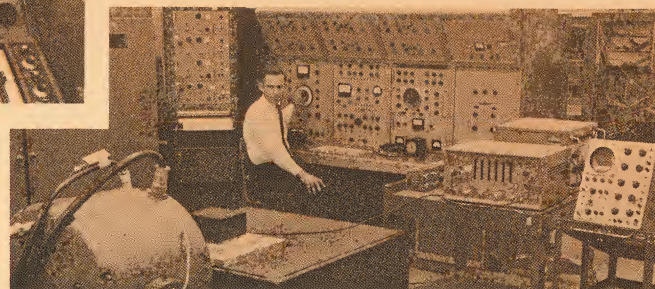
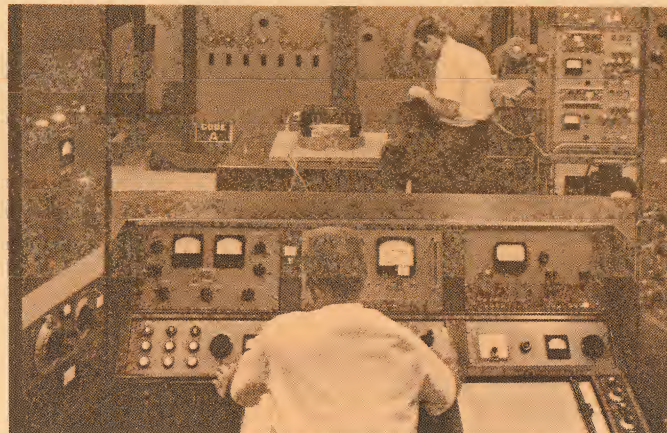
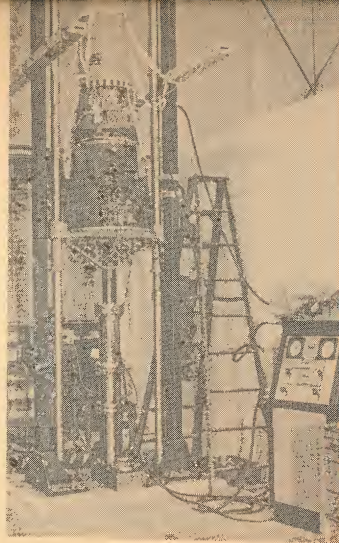




LTV MILITARY ELECTRONICS DIVISION

**TEST LABORATORIES
CAPABILITIES AND FACILITIES**



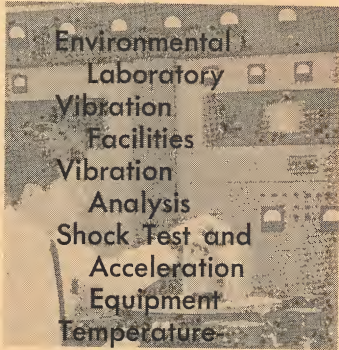
Materials
Laboratory
Metallurgical
Chemical

MATERIALS LAB

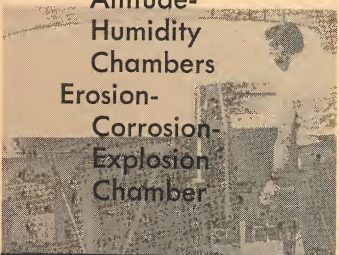


Calibration
Laboratory
Standards
Equipment

CALIBRATION LAB



Environmental
Laboratory
Vibration
Facilities
Vibration
Analysis
Shock Test and
Acceleration
Equipment
Temperature



Altitude-
Humidity
Chambers
Erosion-
Corrosion-
Explosion
Chamber

ENVIRONMENTAL

INTRODUCTION

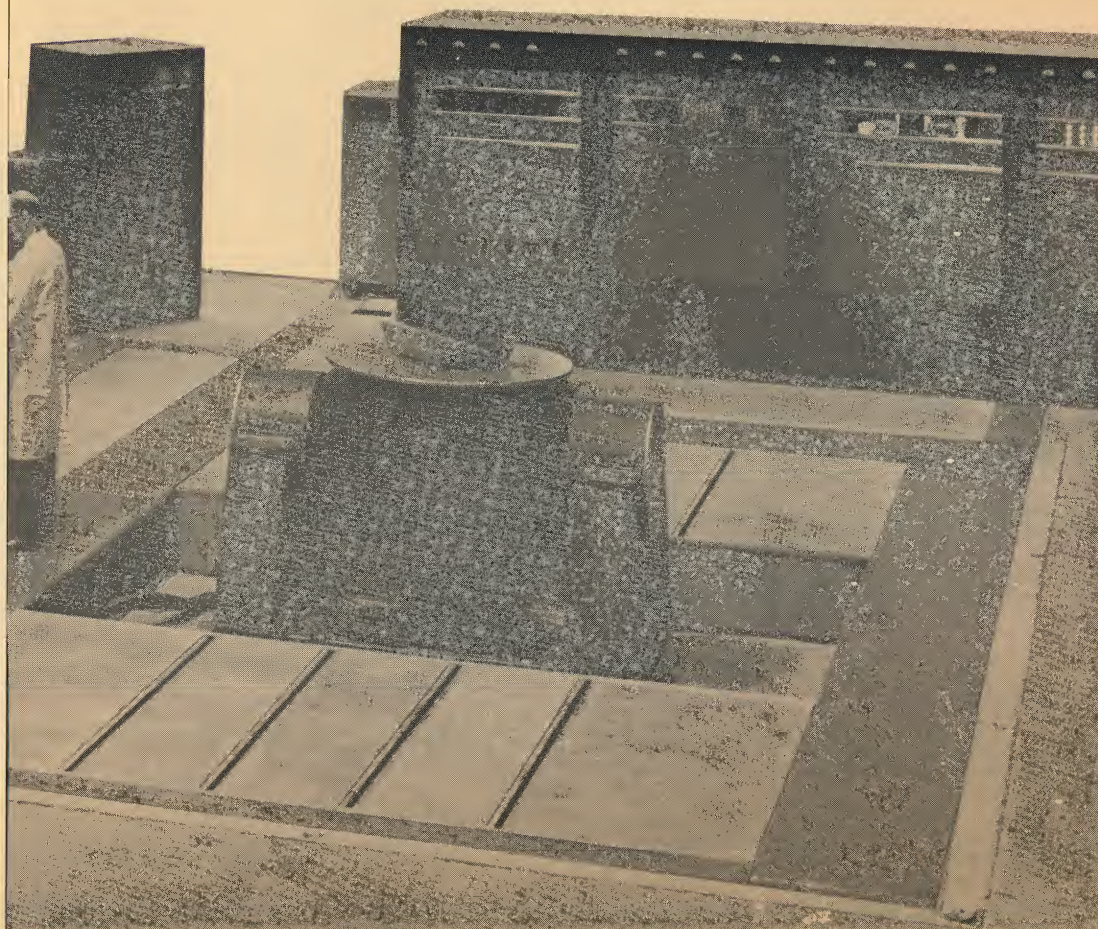
Missile and space vehicle components experience the wicked vibration of blast-off and stage separation, the salty air of a fighting ship's deck, the humid environment of a Cape Kennedy launching pad, and the high-G thump of a hard impact landing before leaving the test laboratories at Ling-Temco-Vought's Garland, Texas facility.

Here, the Military Electronics Division, operates one of the most extensive test laboratories available to industry. Specific test functions described in this brochure include the environmental test facility (including analysis equipment and instrumentation), materials laboratory facilities, and calibration-standard instruments.

In addition to the equipment and personnel permanently a part of the Military Electronics Division, the vast resources of the Ling-Temco-Vought organization make available consultants in the specialized fields of electronics, missiles, manned aircraft, micro-miniature components, and commercial products.

The LTV-MED Test Laboratories can supply the answer to your testing problems. Tests have been performed on contracts varying from short-notice, instant-reaction type projects to long-term evaluation and detail reporting programs. The laboratory's product is testing service. This service includes procedure preparation, test engineering, test performance, and report writing. If you have a need for this type service or anticipate future testing requirements, contact our representative. His office is listed on the back cover of this brochure.

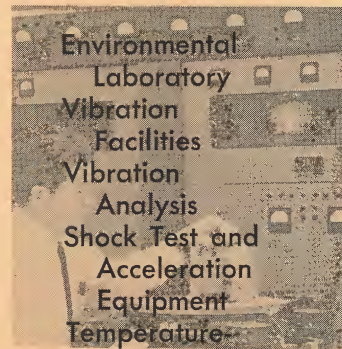
L-200 Vibration System



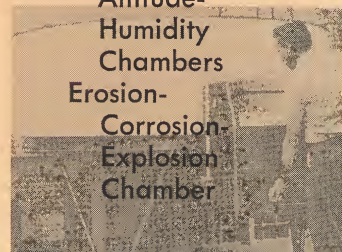


Materials
Laboratory
Metallurgical
Chemical

MATERIALS LAB



Environmental
Laboratory
Vibration
Facilities
Vibration
Analysis
Shock Test and
Acceleration
Equipment
Temperature



Altitude-
Humidity
Chambers
Erosion-
Corrosion-
Explosion
Chamber

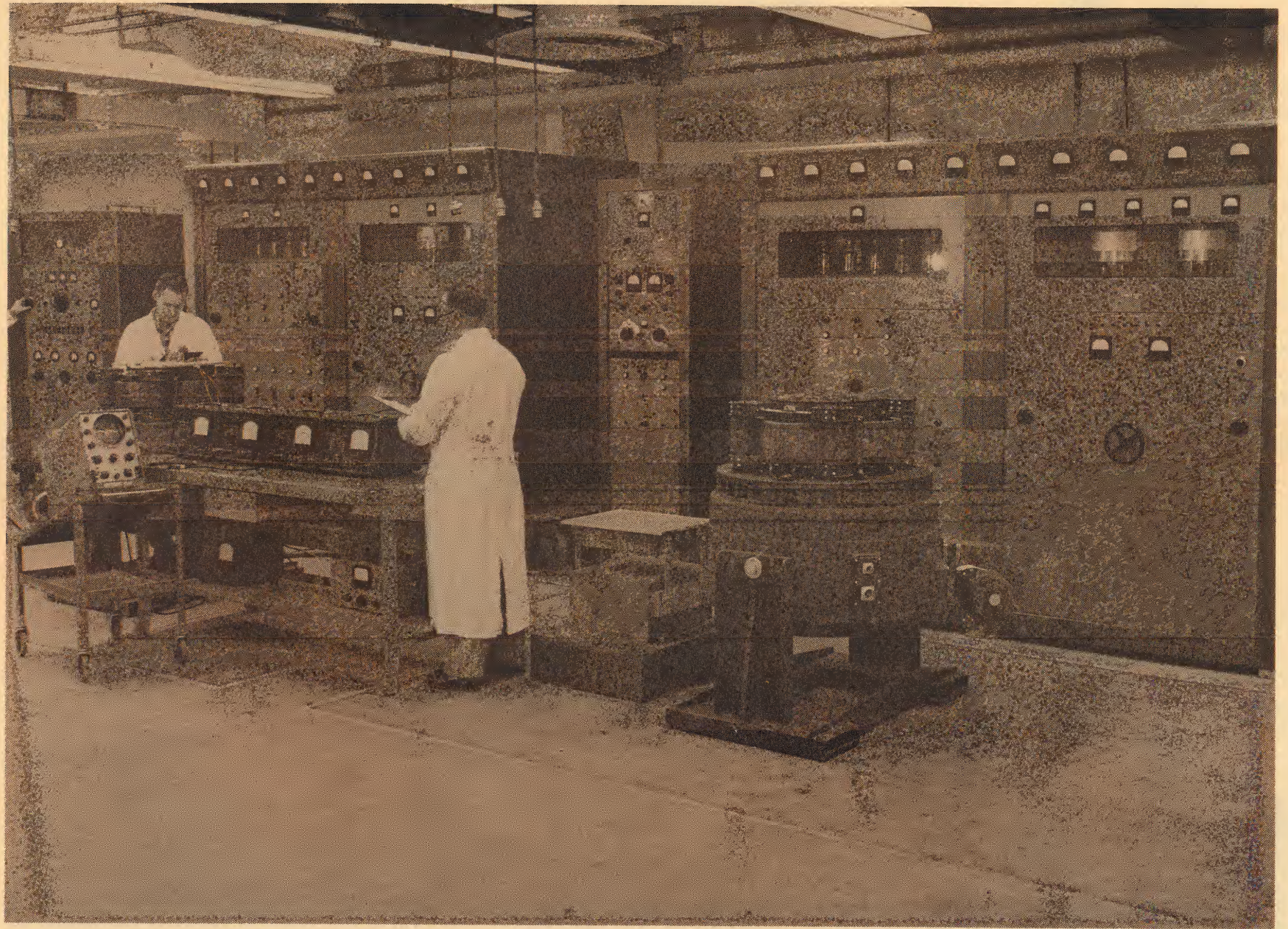
ENVIRONMENTAL

ENVIRONMENTAL LABORATORY

The environmental laboratory contains the facilities necessary to simulate the environments of vibration, shock, acceleration, temperature, altitude, humidity, salt spray, sand and dust, and explosion. Environments consisting of various combinations of these conditions can also be simulated. Military specification compliance qualification of a variety of electronic components can be accomplished. Included among the various aircraft, missile, and space vehicle test programs which have been successfully completed by the laboratory are the environmental qualification of relays, antennas, amplifiers, hydraulic actuators, autopilots, guidance systems, and telemetry components. Major projects and customers included in this past experience are:

CUSTOMER	PROJECT	TEST SERVICE
NASA-Marshall	Saturn	Evaluation of telemetry components
Martin Company	Titan III	Flight certification and reliability testing of various components
Vought Astronautics	Scout and Fire Velocity	Qualification and flight acceptance of components and payloads
Vought Aeronautics	Zuni	Vibration qualification of rocket launcher
Autonetics	Minuteman	Preproduction testing and qualification of hydraulic actuators
Boeing-Seattle	Dynasoar	Qualification of servo-valves
International Data Systems	Saturn Minuteman	Development and qualification of miscellaneous components
Collins Radio	AN/USM-145 (XN-1)	Test Bench qualification
Texas Instruments	AN/APS-80	Vibration qualification
Temco Aerosystems	AN/USD-7 and others	Flight certification of electronic boxes

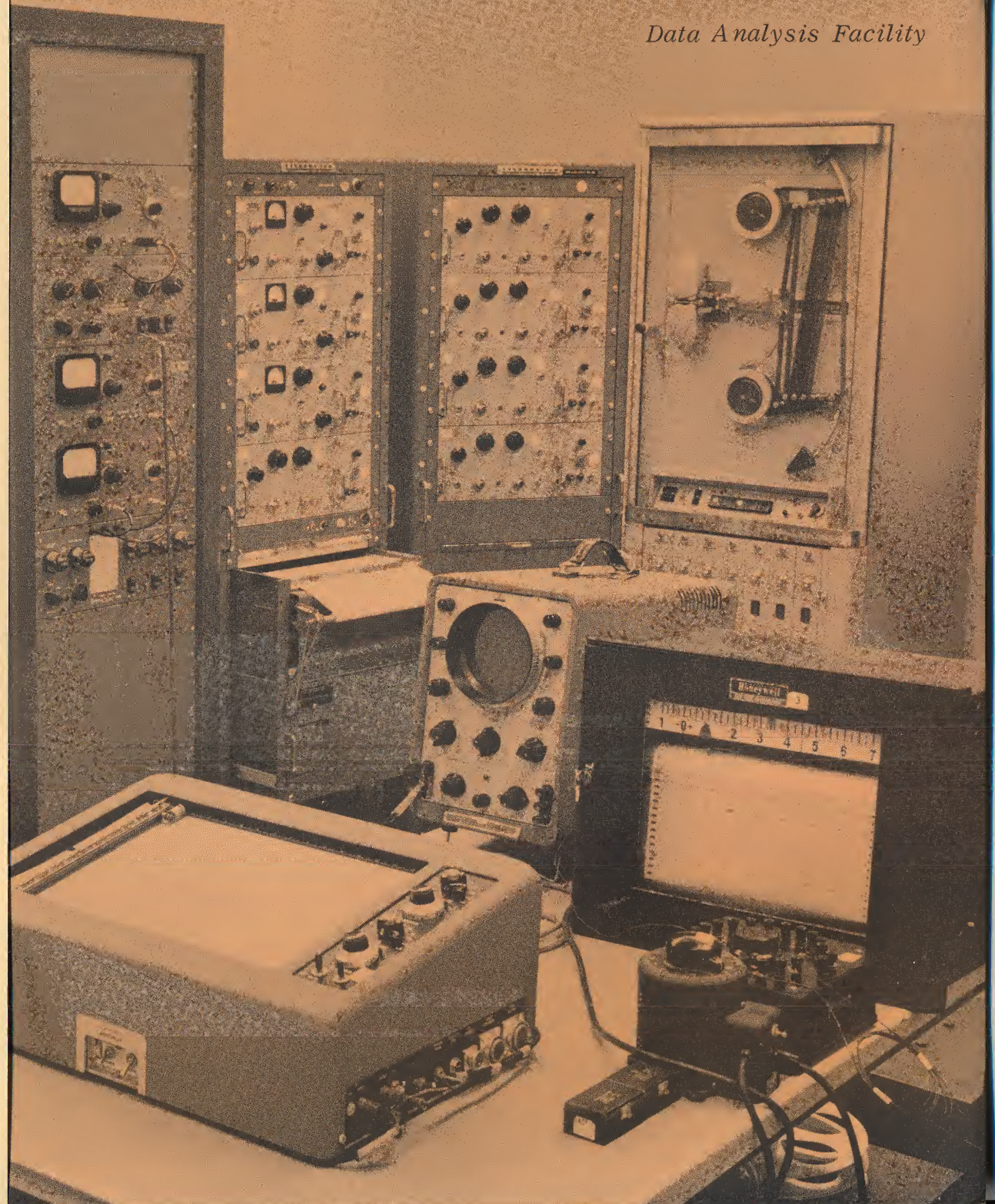
C-25 Vibration Systems



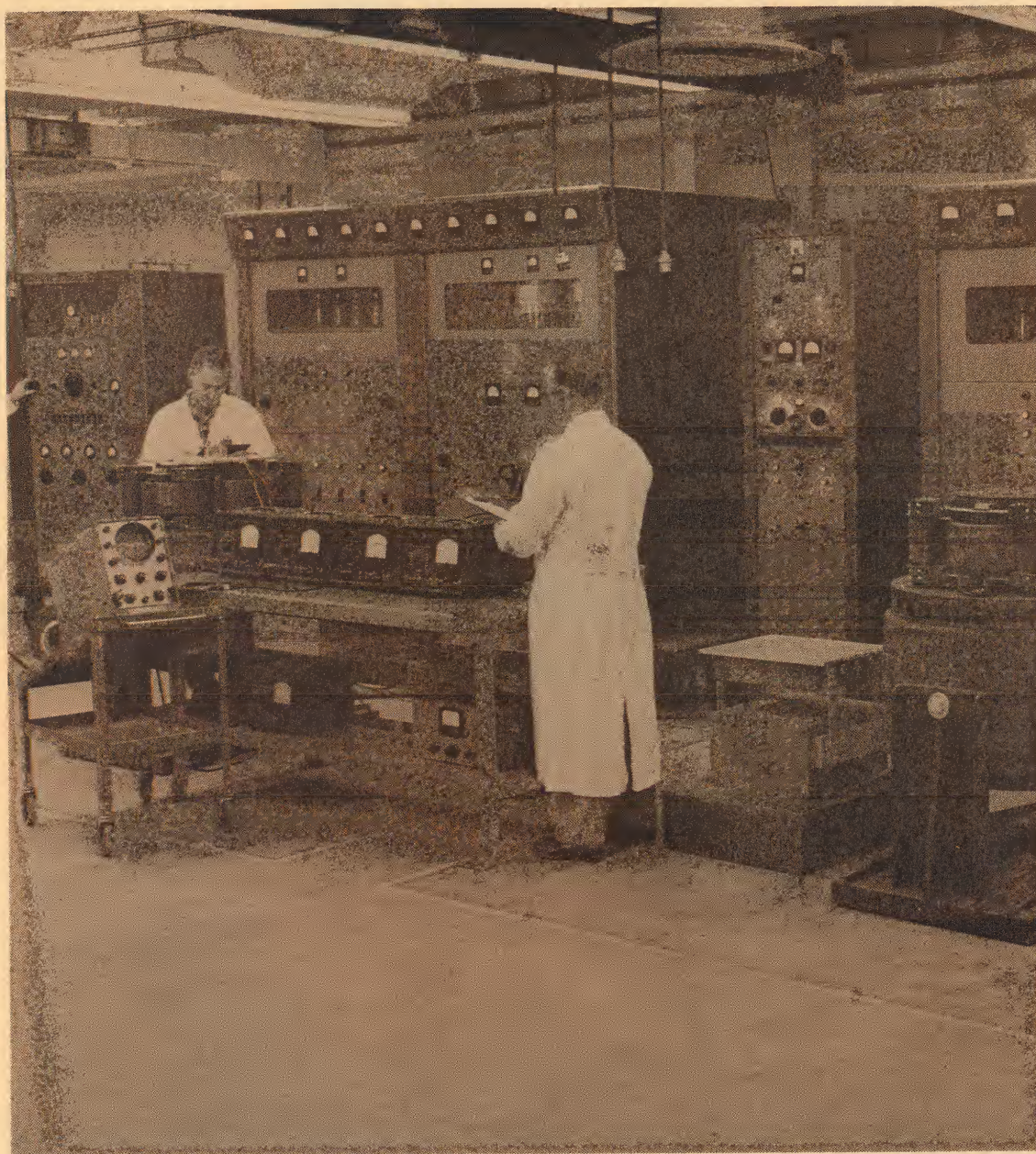
VIBRATION FACILITIES

Associated vibration equipment includes oil film slip tables plus complete, complex wave analyzing equipment with 2, 5, 10, 50, 100, and 200 cps constant bandwidth filters. Specially designed chambers enable vibration to be combined with extreme temperatures.

1. One unit capable of 25,000 force-pounds peak from 5 to 2000 cps with random and sine capability.
2. One unit capable of 22,000 force-pounds peak from 5 to 2000 cps with random and sine capability including 85 channels of automatic equalization equipment.
3. One unit capable of 5,000 force-pounds peak from 5 to 3000 cps with random input.
4. Two units each capable of 3500 force-pounds peak from 5 to 2000 cps. One system is equipped with random input.
5. One unit capable of 1200 force-pounds peak from 5 to 3000 cps.
6. Eight units each capable of 25 force-pounds peak from 5 to 1000 cps.



C-25 Vibration Systems



VIBRATION ANALYSIS

Data acquisition during vibration testing is accomplished using crystal accelerometers, cathode followers, amplifiers, true rms voltmeters, direct writing recorders, and magnetic tape recorders.

Power spectral density analysis is accomplished using a Technical Products Wave Analyzing System, FM tape recorder, and X-Y recorder. The wave analyzing system consists of an oscillator, analyzer, servo-drive, integrator, frequency meters, and constant-bandwidth filters.

Transmissibility characteristics are readily determined with multi-channel direct writing acceleration instrumentation. Endevco Model 2616 amplifiers are used in each channel. Gains are adjusted and fixed during calibration to provide uniform sensitivities between the various acceleration channels. Uniform sensitivities expedite transmissibility determination through direct comparison of the various data channels during the test.

On the manually equalized systems, the vibration exciter response is sinusoidally equalized by the peak and notch filter technique with specimen attached. After sinusoidal equalization of the exciter system, the shaped spectrum is applied at the specified level and a tape recording of the actual environment is made. A power spectral density analysis is then performed on the taped actual environment. A touch-up is then performed on the peak and notch filter system to attain proper spectrum equalization at the specified level. The 85-channel automatic equalization system in the L-200 vibration facility reduces this equalization procedure and time to a negligible amount and provides continuous automatic equalization during the actual test.

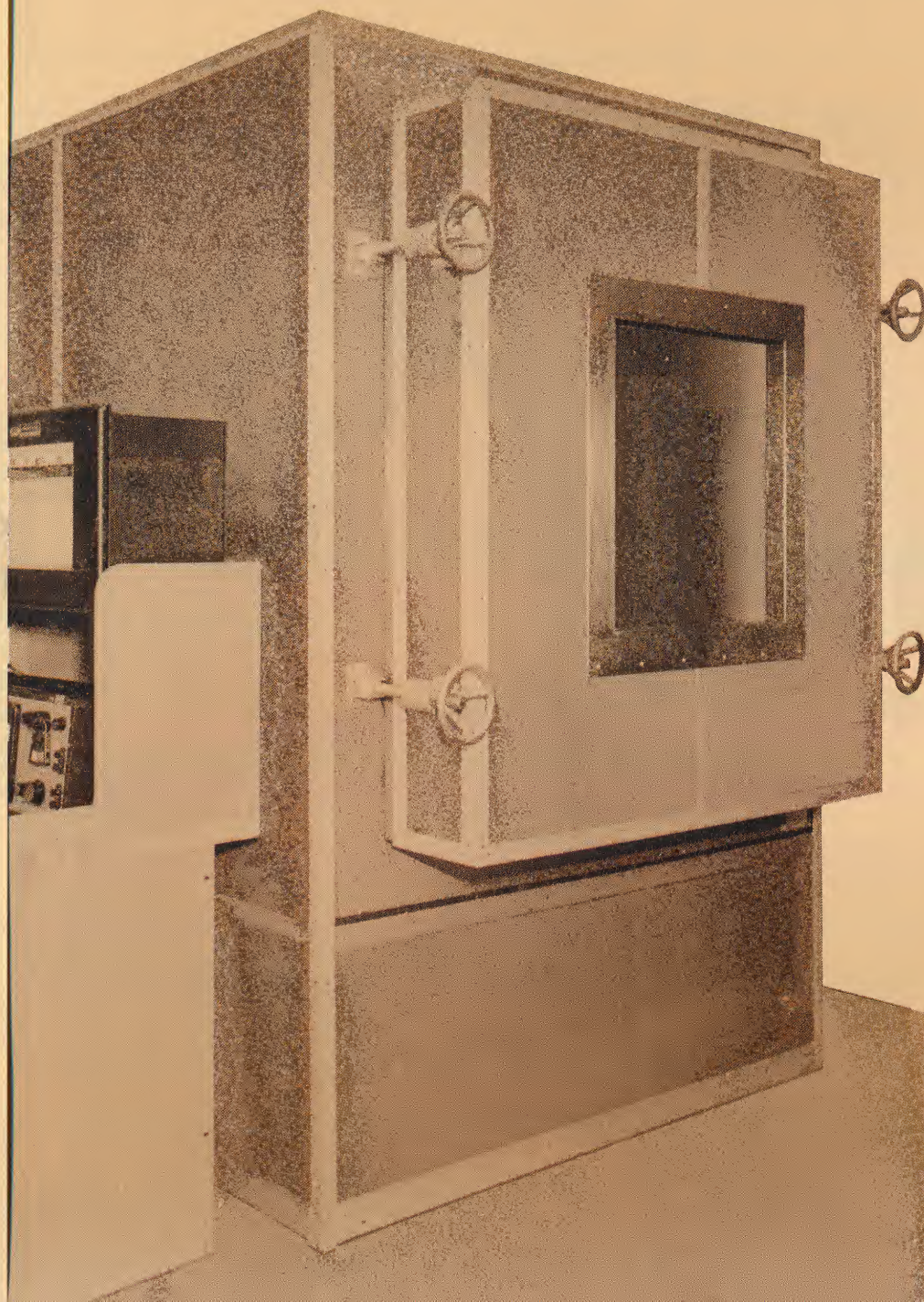
SHOCK TEST-ACCELERATION EQUIPMENT

Shock testing equipment includes:

1. One Hyge unit capable of 42,500 pounds thrust with various pulse shapes and durations. Shock spectra can be simulated utilizing a saw-tooth ramp function.
2. Two Barry 150-400 VD medium impact units capable of shocking packages of 400 pounds up to 76 g's at 6, 11, 24, or 32 milliseconds.
3. One unit capable of shocking packages of 20 pounds up to 210 g's from 1 to 8 milliseconds duration. The shock pulse is a function of the arresting lead pellet shape.
4. Specially designed sand drop fixtures for shock testing large scale equipment.

Acceleration testing equipment includes:

1. One centrifuge capable of constant acceleration up to 10,000 g-pounds. This allows 100 pounds to be accelerated to 100 g's or smaller packages to be tested to a maximum of 175 g's. This accelerator is equipped with 32 electrical slip rings and four pneumatic and hydraulic glands.
2. One rate-of-turn table capable of from 1200 degrees/second to one revolution in 42 days. This permits acceleration testing of small components and performance testing of rate gyros and accelerometers.





Barry 150 - 400VD Shock Machine

Hyge Shock Test Machine



TEMPERATURE-ALTITUDE-HUMIDITY CHAMBERS

Several chambers are available for simulating single environments of temperature, altitude, and humidity or combinations of temperature-altitude or temperature-humidity. These include

1. Two chambers capable of temperature programming and control from -100°F to 200°F , altitudes from laboratory ambient to 100,000 feet, and humidities from 20% to 95% at temperatures up to 160°F . The working space of one chamber is $4' \times 4' \times 8'$ and the other is a $3'$ cube.
2. One chamber capable of temperature control from -100°F to 500°F at altitudes up to 150,000 feet. The working space is a $3'$ cube. One outstanding feature of this chamber is the short time (30 minutes) required to change the temperature from laboratory ambient to -80°F or from laboratory ambient to 500°F .
3. Two chambers capable of being used with vibration exciters to provide a combined temperature-vibration environment. The temperature range of these chambers varies from -100°F to 650°F .
4. Special high heating rate facilities have been designed utilizing T-3 quartz lamps with manual on-off control. Operators have been able to control specimen temperature within ± 2 degrees of a 20 degree per second profile.
5. Several humidity chambers meeting the requirements of MIL-E-5272 and MIL-STD-202.
6. Numerous portable chambers with low- and high-temperature capabilities.

EROSION-CORROSION-EXPLOSION CHAMBERS

Salt fog chambers are available to provide MIL-spec corrosive atmosphere for qualification of products varying from small electronic black boxes to large assemblies. In addition, one chamber is operated continuously as part of the certification of processing tanks. These tanks provide protective finishes primarily to sheet metals.

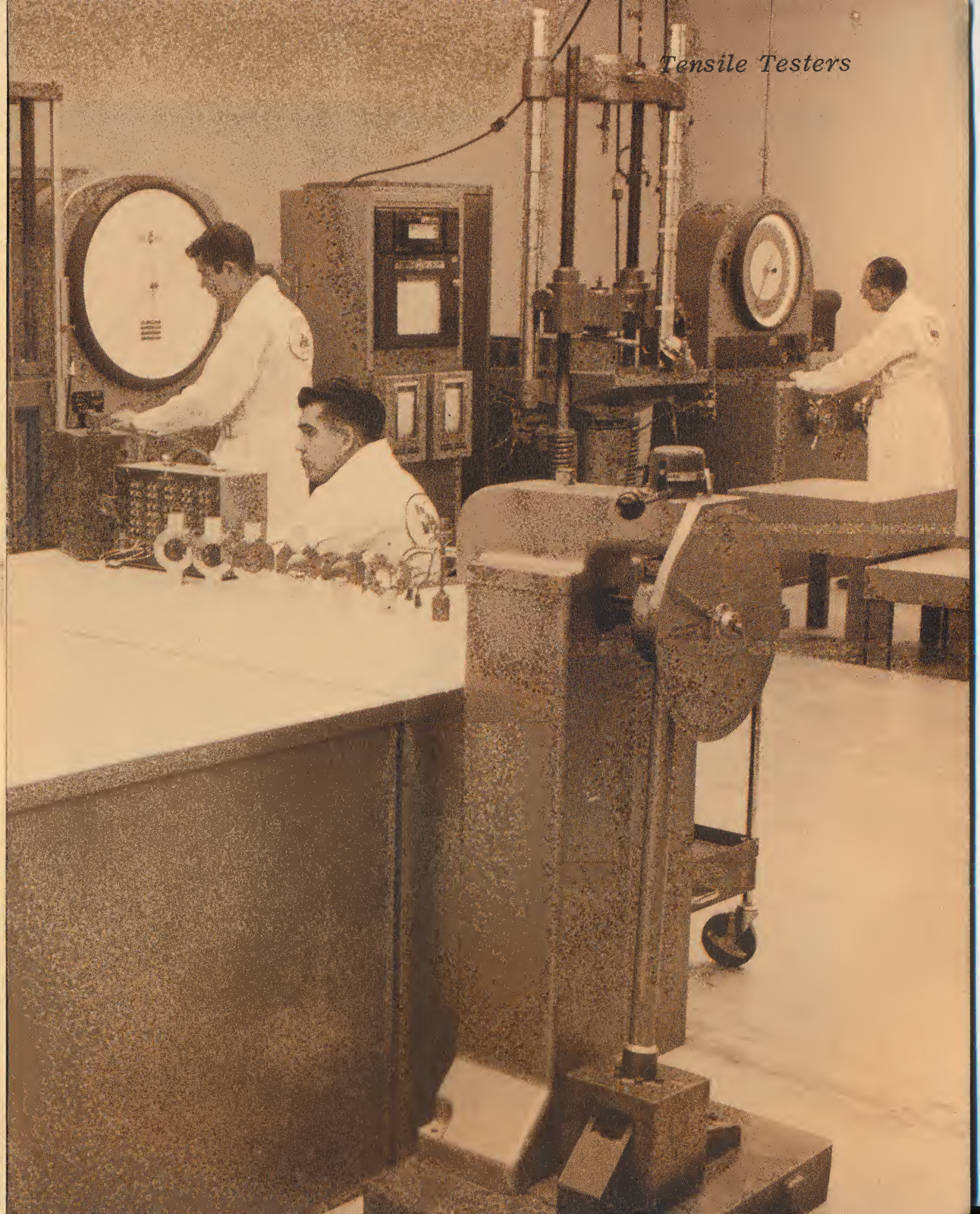
The salt fog equipment includes:

1. One chamber 1.5' x 2' x 4'
2. One chamber 1.5' x 2' x 9'
3. One walk-in chamber 5' x 8' x 17'

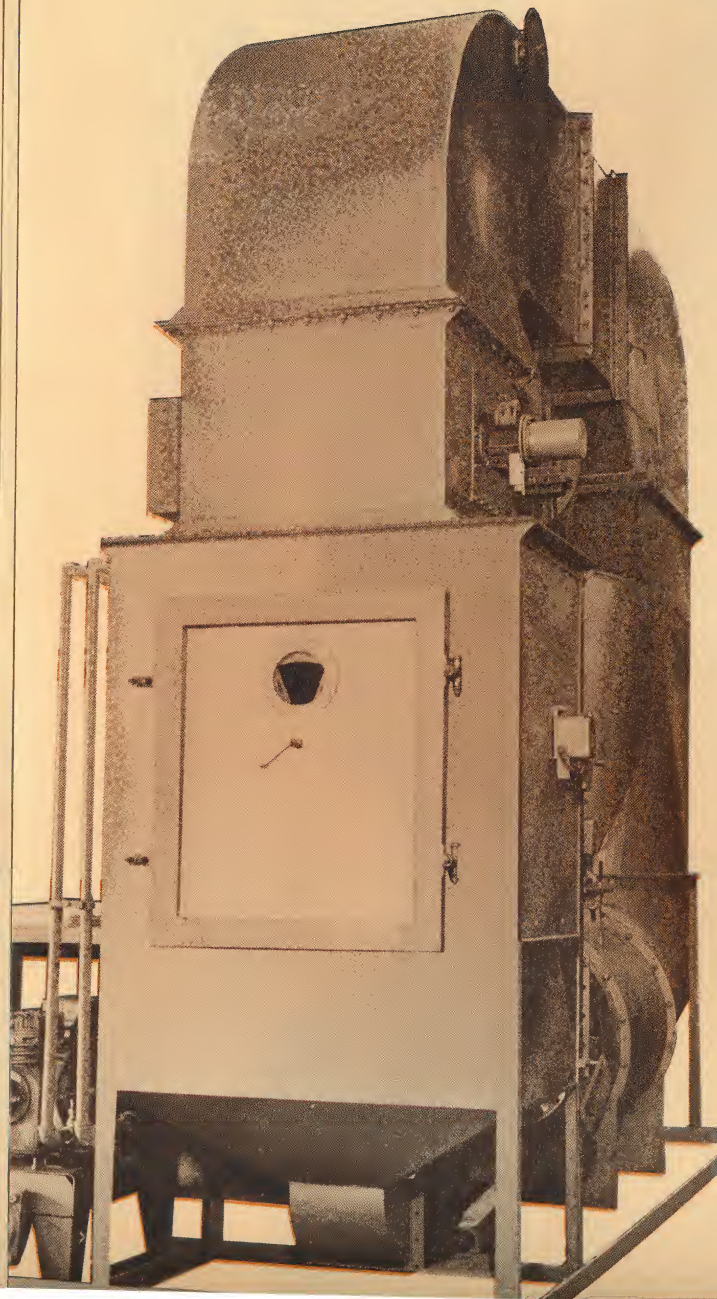
Erosive environments are simulated with a sand and dust chamber. This chamber can provide wind velocities from 200 ± 100 feet per minute to 2300 ± 500 feet per minute. Temperature conditions can be varied from laboratory ambient to 160°F . This chamber has a floor space area of 30" x 30" and a height of 30". The height can be increased to 60" with minor modification.

An explosion chamber is available with working space 4' long and 2.5' in diameter. This unit is capable of providing explosive conditions conforming to MIL-E-5272 and MIL-E-5422 conditions using butane. Modification has been being accomplished to include capability of testing with JP-4 and other fuels.

Tensile Testers



Sand and Dust Chamber



MATERIALS ANALYSIS AND PROCESS CONTROLS LABORATORY

The Materials Analysis and Process Controls Laboratory has experienced personnel and extensive equipment for structural and mechanical testing, metallurgical investigations, and chemical analysis. This laboratory performs numerous functions including metallic and non-metallic material evaluation, chemical process control, incoming material inspection, mechanical material tests, clean room contamination measurement and control in addition to the performance of failure analysis for other sections.

Mechanical property determination utilizes fatigue testing, impact machines, and several tensile test machines with capacities up to 60,000 pounds. These tensile machines are equipped with load and strain rate control accessories. In addition, tensile, compression, and shear testing can be performed at temperatures up to 2000°F.

Typical examples of test programs which have been performed in the Materials Laboratory include:

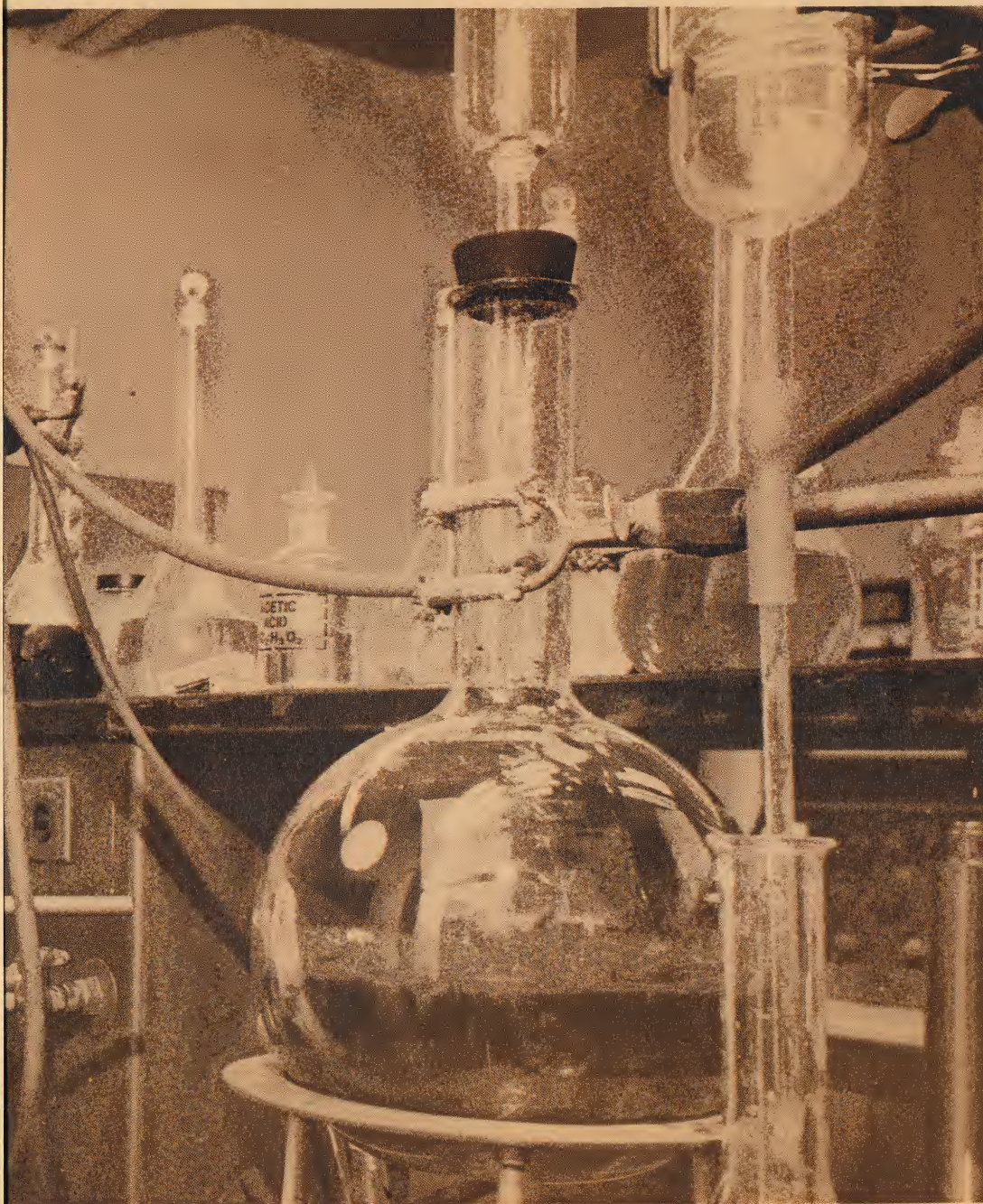
1. Evaluation of the effects of shear forming on 32 materials (aluminums, stainless steels, titanium, and super alloys).
2. Evaluation and production control testing of plastic sandwich parts for KC-135 aircraft.
3. Investigation of the effects of salt fog in producing stress corrosion in aluminum materials.
4. Development and qualification testing of quick-operating rotary fasteners.
5. Determination of retained austenite in electro-hydraulic valves for Minuteman and Titan III programs utilizing X-ray diffraction methods.

METALLURGICAL

The metallurgical section of the Materials Analysis and Process Controls Laboratory is equipped for extensive investigations of all types of metals used in LTV's products. Heat treating facilities within the laboratory enable the metallurgist to study material variations due to processing techniques. The metallograph provides visual or micro-photographic studies to 1000 magnifications. The X-ray diffractometer permits study of crystalline structure and quantitative analysis of elements. Equipment is available for sectioning, mounting, grinding, polishing, and etching of metallographic specimens. These and other equipment permit performance of incoming material identification, evaluation of in-process structural components, and assistance in research and development programs for the division.

Typical activities in the metallurgical section are:

1. Spectrographic determination of trace elements in incoming structural materials such as 17-4 steel, and 7075 and 7079 aluminum alloys.
2. Metallurgical examination of castings and weldments in support of manufacturing and engineering operations.
3. Investigation of impurities and contamination of small electronic components. The determination of extraneous deposits on the contacts of a miniature coaxial switch is one instance.
4. X-Ray diffraction studies of a ceramic material for local industries.
5. Assistance in an engineering study of the deformation of the cross-section of electrical conductors resulting from the installation of a crimped connection.



Sand and Dust Chamber



CHEMICAL

The Chemistry laboratory is equipped to perform analyses of organic and inorganic compounds as required. Equipment is available for performing volumetric, electrometric and/or gaseous analysis. One of the functions performed in the laboratory is the surveillance of alodining, anodizing, plating, and printed circuit board manufacturing processes. Experienced personnel are available to assist in design and manufacture of the company's products.

The surveillance of manufacturing processes consists of the preparation and maintenance of a process control system which includes writing of operational procedures, chemical analysis of process solutions on a recurring basis, and correction of processes when required. A record system is maintained with current operational procedures, results of analysis, and corrective action in compliance with current military specification requirements.

In addition, the Chemistry Laboratory provides engineering development and evaluation services as required to support manufacturing and engineering operations. Some typical support services are:

1. Identification of products of corrosion on a milling machine, and the selection of a proper lubricating coolant and corrosion inhibitor which will prevent reoccurrence.
2. Assistance to engineering in the evaluation of a material salvage procedure for improperly dip brazed aluminum parts.
3. Disposal of toxic waste materials such as cyanides, explosives, acids, alkalies, and salts used in engineering and manufacturing operations.

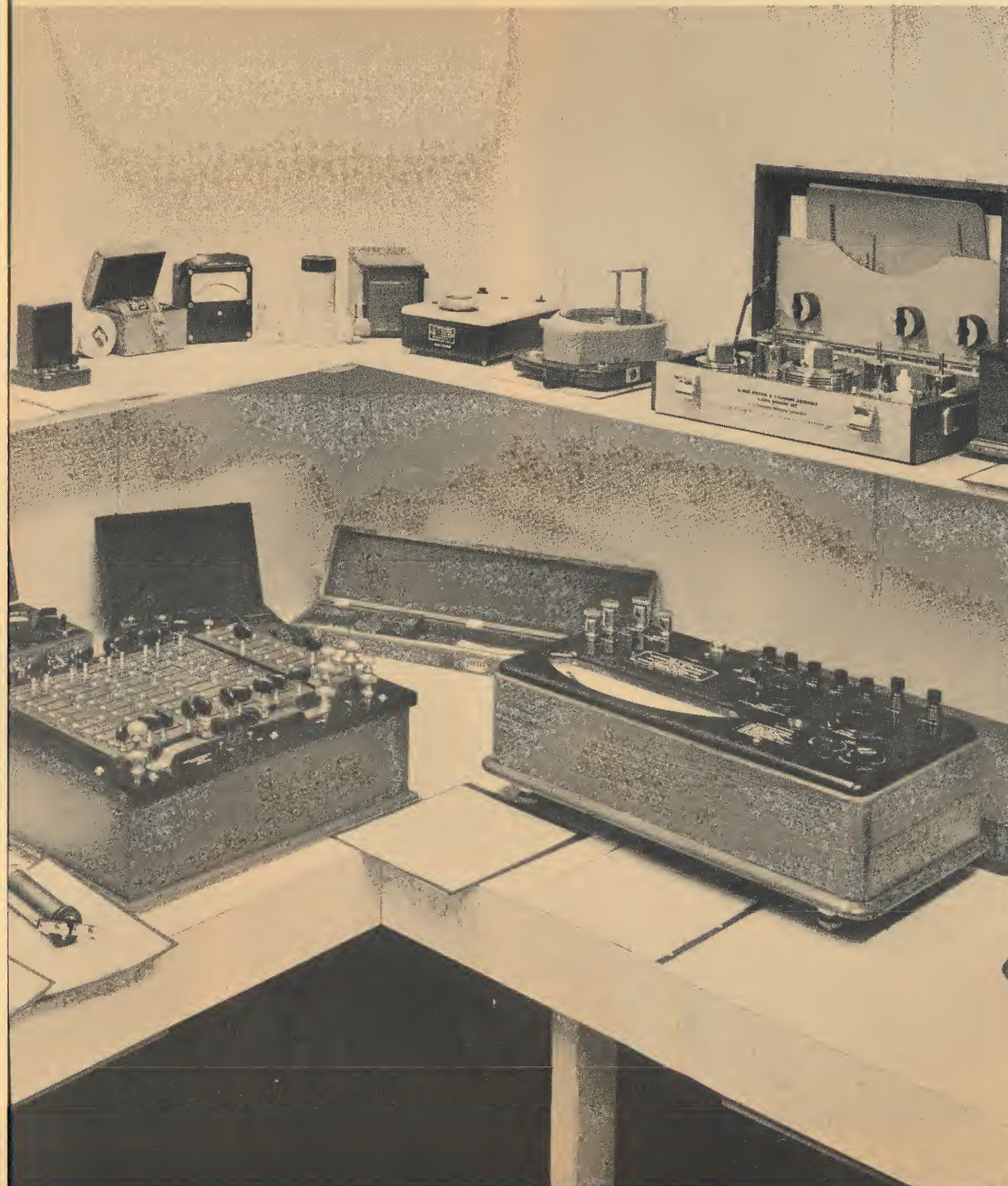
CALIBRATION SERVICE

To a large extent, the accuracy of any measuring instrument depends upon the care given it in service. For this reason, all Military Electronics measuring instruments are given periodic inspection, calibration, and tests. To accomplish this task a 4-part program is carried out. Each part of the program is separate but all are inter-related. The four parts are:

1. Preventive maintenance
2. Calibration
3. Repair of defective instruments
4. Record-keeping and recall system.

The Military Electronics reference standards are located in the Instrument Repair and Calibration Laboratory in a temperature- and humidity-controlled, positive pressure environment. Reference standards of voltage, resistance, capacity, inductance, temperature, pressure, mass, and weight are forwarded at scheduled intervals to the National Bureau of Standards for certification and are regularly cross checked against other standards. A continuing efforts is exerted to improve the capability of the calibration laboratory by addition of new equipment and the training of personnel.

Engineers and technicians are constantly increasing their skills through in-plant training courses, college courses, and factory training courses.





STANDARDS EQUIPMENT

Acceleration	0.25 to 10,000 G's
Endevco Accelerometer and Cathode Followers	20 to 10,000 cps
Acoustics	20 to 16,000 cps
Bruel and Kjaer Microphone	80 to 140 db
Capacitance	5 mmf to 1 mf
General Radio Bridge and Capacitors	
Current, A-C	2 ma to 10 amps
Sensitive Research Volt-Ammeter	380 to 420 cps
Current, D-C	1.5 ma to 15 amps
Leeds and Northrup Potentiometer and Shunt	
Sensitive Research Volt-Ammeter and Shunt	
Frequency	1 cps to 19 kmc
Hewlett-Packard Counter, Converter, Multiplier, Transfer Oscillator System	
Pressure	0.3 to 100,000 psi
CEC Standard Ideal Aerosmith Barometer	
Aminco Deadweight Tester	
Resistance	0.1 to 100,000 ohms
Leads and Northrup Bridge	
Minneapolis Honeywell Resistors	
Strain	0 to 25 micro inches
Ammco-Tuckerman Optical System	
Temperature	32°F to 2600°F
Leeds and Northrup Thermocouple and Potentiometer	
Voltage A-C	2 to 500 volts
Sensitive Research Volt-Ammeter	380 to 420 cps
Voltage D-C	0.001 to 1500 volts
Weston Standard Cell	
Epply Standard Cell	

SUPPORT SERVICES

One of the outstanding assets of LTV Military Electronics is the availability of corporate support by Ling-Temco-Vought throughout the entire range of technology. For in any project, the vast facilities of LTV organization stand ready to support the experience and performance of Military Electronics. These facilities include:

1. Radio frequency interference (RFI) equipment at the modern Radiation Laboratory of Temco Aerosystems. This equipment is capable of testing components and systems to the requirements of MIL-I-6181D and MIL-I-26600.
2. Space environment simulator at the Vought Astronautics Division. This chamber has the following capability:
 - Pressure, 10^{-7} mm Hg
 - Solar Radiation, 400 watts/square meter
 - Temperature, -320°F
 - Motion, 2-axis universal gimbal
 - Speciman Size, 8-foot diameter
3. Radiant heating facility at the Vought Aeronautics and Missiles Division. This equipment can program and control up to 1050 KVA. Flux density up to 150 btu per square foot can be provided readily using liquid cooled T-3 quartz lamps. Systems in the 100 KVA category are available in the Electronics Division.
4. Flow facilities with capabilities in excess of 1300 gallons per minute and fuel compatibility facilities are available in the Military Electronics Arlington facility.

Supervisor of Materials and Process Laboratory; BSME, Texas A & M, 1953; Advanced Studies, SMU, 1955-57; Member of AS and ASTM. Mr. Fodge was employed by Chance Vought Aircraft in 1953. He was assigned to a reliability analysis group to conduct environmental evaluation tests on Regulus components and subsequently to prepare reliability test programs on stabilization systems for the Regulus I and II missiles and for the autopilot systems for the F8U-1 crusader. In 1956 Mr. Fodge was assigned to direct engineering test activities on F8U-2 and F8U-3 autopilots, an F8U-3 radar system, and R&D studies of acoustic test techniques. In 1960 Mr. Fodge assumed the position of Supervisor, Environmental Test Laboratory and directed the activities of engineers and technicians on Crusader systems, Lockheed subcontracts, Minuteman actuators, and Scout production environmental test program. Since 1961, he has directed qualification test programs on ground support equipment for Burroughs, A. C. Spark Plug, and AAMA in addition to his responsibilities in the Materials and Process Laboratory.

R. W. Fodge



B. L. Nieswiadomy

Benedict L. Nieswiadomy, BSEE, Supervisor of Environmental Operations. Joining the LTV-MED Environmental Test Laboratory in 1957, he performed development tests on the CORVUS vehicle components. He conducted the qualification tests of the TT-1 jet trainer electrical system, and evaluated the training mockup of the TT-1 electrical and hydraulic systems. He subsequently conducted qualification tests of the ALPHA aerial surveillance system. He also performed evaluation and qualification tests of the assembled CORVUS vehicle, including the electrical, guidance, and stabilization systems. He participated in the evaluation of a parachute recovery system for the CORVUS vehicle, and in the integration tests of the CORVUS vehicle with the launch aircraft. He has also performed flight flutter tests on both the C-130A and C-130B military aircraft. In addition he has been responsible for the evaluation of Scout vehicle components. Currently he is directing the testing program relating to the Saturn and Lance vehicles. The Saturn program is a testing service contract with NASA-Marshall for reliability testing of Saturn telemetry components.

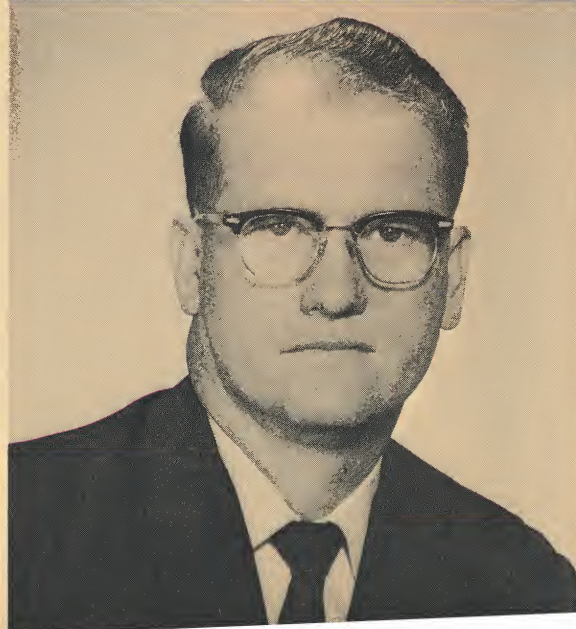


N. G. Orton

N. G. Orton, BSEE, Supervisor, Test Laboratory Projects, Member of Institute of Environmental Sciences. Mr. Orton was responsible for flight and production test methods and performance on the ANASQ-42V Navigation and Bombing System for the B-58 while at General Dynamics, Ft. Worth. In addition, he acted as a consultant to field engineering personnel on field problems encountered in the Navigation and Bombing System. After joining LTV-MED, Mr. Orton conducted environmental tests on RAM; Project 279; Junior Vehicle; Scout components, missile sections, and payload structures. He is presently responsible for functional, environmental acceptance, reliability, and qualification all testing related to Scout and FIRE Velocity vehicle projects. Test articles range from payloads and transition sections to components such as beacons, transmitters, relay boxes, end instruments, and telemetry assemblies.

C. D. Robbins — Environmental Test Specialist, B.A. — Hardin-Simmons University, M.A. — Arkansas University, Advanced Studies — Oklahoma University and UCLA. From 1950 to 1958 Mr. Robbins taught mathematics and physics at Arkansas State Teachers College, Corpus Christi University and Oklahoma University. During 1958-59, as Research Test Engineer at Douglas Aircraft, he directed various test projects on the DC-8 airplane and Thor missile. He attended the seminar on random vibration at Yale University, participated in the activities of the Society of Environmental Engineers and was a member of the committee on sine-random equivalence. Since joining LTV in 1959 he has performed the duties of a technical specialist on test projects such as combined high temperature (4000°F) and vibration tests, random vibration problems and analysis of flight vibration data. Mr. Robbins currently directs the efforts of a group of test engineers and acts as technical consultant to all Test Laboratories groups. He is a member of the Mathematical Association of America and the Institute of Environmental Sciences and has presented a number of papers at national symposia.

C. D. Robbins



J. C. Shackelford

J. C. Shackelford — Supervisor, Standards Laboratory, B.S.E.E. — Southern Methodist University, Advanced Studies SMU. Mr. Shackelford is responsible for planning, implementing and supervising a calibration program to meet the requirements of MIL-C-45662A. He has established a written calibration system that prescribes calibration interval, calibration procedures, reference standards, environmental controls, records, and recall methods and supervised the efforts of instrument repair and was responsible for the preparation of design, procurement and test specifications for components used on the Regulus and F8U-1 Crusader. He assisted in the design, fabrication and test of radio command, trounce guidance and bipolar test sets used to support the Regulus flight program. As electronics liaison engineer for the CV/AES-6 F8U Autopilot System, he coordinated effort on this program throughout design, fabrication, ground test, and flight test phases. Mr. Shackelford has been a member of the Test Laboratories organization since 1958 and is a participant in the National Conference of Standards Laboratories.

VIBRATION EQUIPMENT

One 5,000 force-pound system

Exciter: Model C-50
(46-pound armature)
Amplifier: Model 4150
(17-KVA output)
Frequency Range: 5 to 3000 cps
Control Console: Random and/or Sinusoidal

Two 3500 force-pound systems

Exciter: Model C-25H
(75-pound armature)
Amplifier: Model PP20/20B
(20-KVA output)
Frequency Range: 5 to 2000 cps
One unit random and/or sinusoidal
One unit sinusoidal

One 1200 force-pound system

Exciter: Model C-10-H
(17.5-pound armature)
Amplifier: Model PP 7/8
(7-KVA output)
Frequency Range: 5 to 3000 cps
Control Console: Sinusoidal

One Hydraulic slip table 44" x 44"

One Hydraulic slip table 30" x 30"

One 25,000 force-pound system

Exciter: Model A-182
(320 pound armature)
Amplifier: Model PP 175/240
(175 KVA output)
Frequency Range: 5 to 200 cps
Control Console: Random and/or Sinusoidal
with 85-channel dynamic
automatic equalizer/analyzer

One 22,000 force-pound system

Exciter: Model L-200
(115 pound armature)
Amplifier: Model PP 175/240
(175 KVA output)
Frequency Range: 5 to 2000 cps
Control Console: Random and/or Sinusoidal
with 85-channel dynamic
automatic equalizer/analyzer

VIBRATION INSTRUMENTATION

Piezoelectric Accelerometers

Endevco Models: 2211, 2212, 2213, 2242
Acceleration: 0.25 to 10,000 g's
Frequency: 20 to 10,000 cps
Temperature Range: -100°F to 500°F

Voltmeters

Ballentine Model: 320 True rms
Hewlett Packard Model: 400D and 410B

Oscilloscopes

Hewlett Packard Model: 130A, 130B, 150B
Tektronix Model: 535, 545, 585
Hughes Memoscope Model: 104

Recorders

Sanborn Models: 156-5460 and 158-5460
Preamplifiers: 150-1000, 150-1200,
150-1400 and 150-2600

CEC Model: 5-114-P3
Galvanometers: All types

Brown Temperature
Model: Multipoint and Strip Chart
Range: -100°F to 700°F

CEC Model: F-M Tape
Channels: 14 Record; 7 switched
Playback

Speed: 1- $\frac{1}{2}$ ips to 60 ips

Telemetry Ground Station

Type: FM/FM and PW/FM
Channels: 100

Floor Space:

Over 10,000 square feet of air conditioned floor space is occupied by the test Laboratories.

Personnel:

LTV-MED Test Laboratories are staffed by 26 Test Engineers and 28 Test Technicians with experience ranging from 2 to 20 years in the Test Business.

FOR FURTHER INFORMATION CONTACT YOUR NEAREST REPRESENTATIVE

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